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RECENT ADDITIONS TO THE WEATHER BUREAU LIBRARY.

H. H. KIMBALL, Librarian.

The following titles have been selected from among the books recently received, as representing those most likely to be useful to Weather Bureau officials in their meteorological work and studies. Most of them can be loaned for a limited time to officials and employees who make application for them.

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NOTES AND EXTRACTS.

A GUIDE TO THE OBSERVATION OF EARTHQUAKES.

The Strassburg Seismological Station has distributed a circular[1] throughout the world to all German consuls that will, it is hoped, concentrate our efforts to record and collect earthquake data. As we now reprint this circular we will request all to send their observations to the nearest consulate of the German Empire, or to the German Consul-General in New York, or direct to Prof. H. F. Reid, Johns Hopkins University, Baltimore, Md., or to the Editor, who will forward them properly. These observations will not be printed in the MONTHLY WEATHER REVIEW, but the records from our Weather Bureau seismographs and the special studies of Professor Marvin will be thus printed for the information of all.

[1] Reprinted from Beiträge zur Geophysik, 1905. VII Bd. 4 heft.

A GUIDE FOR THE OBSERVATION OF EARTHQUAKES.

1. IMPORTANCE OF THE INVESTIGATION OF EARTHQUAKES.

Few branches of science have in the last few years received such a great impetus as the investigation of earthquakes. The modern investigation of earthquakes dates from the time when, by the construction of highly sensitive seismic instruments, it was made possible to register at any point of the surface of the earth all strong shocks of the earth's crust. The perfection which these instruments have lately reached places us in a position to trace around the earth the elastic waves proceeding from an earthquake with sufficiently strong intensity.

The number of stations equipped with such instruments is, however, still very limited; their distribution over the earth's surface has not been according to one uniform plan, but was dependent on necessary conditions which were frequently by chance fulfilled in a less appropriate place, but not in another more suitable one. The efforts of the International Seismological Association, which was founded in the year 1903 at the Second International Seismological Conference at Strassburg and to which almost all civilized nations belong, will in the first place be directed to creating a systematically arranged net of earthquake stations and to establishing observations according to uniform principles.

The records which the seismic instruments have so far given have already thrown important light on the nature of earthquakes, and above all on the nature of the movement, on the phases of which seismic disturbances are composed, on the direction from which most earthquake waves come, on the speed with which seismic waves are transmitted through and over the earth. But the principal value of modern investigation of earthquakes consists in the fact that, by the use of seismic instruments, it supplies a means for obtaining a better conception, than was for a long time possible, of the state of the interior of the earth, which is entirely concealed from direct observation.

In the meanwhile, instrumental observation alone is not yet sufficient to solve the most important problems of earthquake investigation. The first question of seismology concerns the establishment of "seismicity," i. e., of the seismic behavior of the whole earth.

In former years the attempt was made again and again to work out a catalogue of all seismic disturbances, and to publish annual specifications of all known earthquake disturbances in the form of a chronicle. The purpose thus aimed at was chiefly to discover the points or districts of the earth which are subject to shocks and from which the earthquake waves radiate over more or less great surfaces.

On account of the inadequacy and incompleteness of the reports of earthquakes in former years, it was impossible even to do tolerable justice to the first seismological problem. The manifold bonds, however, which to-day unite the nations to one another permit the hope that, by all the nations of the earth working together to a conscious end, it will be possible to solve a question which was formerly impossible of solution on account of international prejudices and jealousies.

In the first place it is the intention to publish a seismic atlas on the basis of the material stored up in the existing catalogues of earthquakes. This atlas is to give a cartographical representation of the extent of earthquakes and particularly of the position of the epicenters.

The second problem of seismology is to determine the relation of the position of the epicenters to the geological constitution of the districts in question, whether it is a temporary or a permanent relation, whether earthquakes displace the point of emergence, whether the energy of seismic activity is subject to changes in point of time and place, and lastly whether the frequency of earthquakes is periodic or not.

In the former state of earthquake investigation a solution of all these questions was not to be thought of, and even now many years of observation and a collection, as complete as possible, of earthquake data will be necessary if we wish to advance in this respect, for it is just in this second problem that instrumental observation alone does not suffice; here, on account of the personal observation necessary, science must fall back upon the voluntary cooperation of all educated people. From the records of the seismic instruments we can only gather the nature of the movement at the place of observation itself; we learn nothing about the extent and shape of the shaken area, about the different indications of intensity within the shaken district, or about the manifold accompanying phenomena.

Instrumental records and personal observations thus form a necessary complement of each other. If earthquake observation and investigation is henceforth carried on everywhere in this modern sense, seismology itself will have the first and greatest benefit. But there will also be a general, direct, practical profit from it. When the nature of earthquake waves has been more exactly investigated, when the correlation of the various manifestations of seismic power with the local conditions, which perhaps produce such manifestations, becomes better known, when we have established the chief epicenters and their appurtenant shaken districts, it will be possible, if not to indicate the earthquakes in advance, at least to find ways and means whereby the most destructive effects of the earthquakes can be obviated and life and property be saved.

It is the privilege of all educated people of the earth to collaborate in this great and difficult task.

The following remarks aim to present in a generally comprehensible manner the principal earthquake phenomena the exact observation of which is most important, thereby enabling everybody who is interested to collaborate in the service of science and for the good of mankind. Thereto are added instructions for the answering of questions, if it should be necessary, and the filling up of the accompanying question cards. In conclusion there is given a question card which may serve as a model, the data of which are taken from an actual case.

2. THE MOST IMPORTANT EARTHQUAKE PHENOMENA.

Earthquake is the name given to all those shocks, whether they can be perceived by the human senses or not, which owe their origin to any disturbance of equilibrium in the earth's mass, and which are transmitted, in the shape of spherical waves, as elastic vibrations, i. e., as waves of compression and rarefaction, through the medium of the earth's body from their place of origin. If the place at which the earthquake waves leave the earth's crust lies at the bottom of the sea, and if the spherical waves are transmitted across the body of the water to the level of the sea, it is called a submarine earthquake, or seaquake.

(a) The shock of an earthquake.

The periodically alternating compression and rarefaction of the material of the earth's crust which are caused by the disturbances of equilibrium in the bowels of the earth, form the waves of compression and rarefaction, the movement of which is divided into a vertical and a horizontal component. On account of the immense energy of tension and movement which is contained in the elastic waves, earthquakes show themselves in sudden shocks of different intensity.

Immediately above the subterranean earthquake seat and also in the neighborhood of the epicenter the vertical component preponderates. To human perception the shock of an earthquake makes itself felt as a shock from below in an upward direction. As the distance from the epicenter increases, the vertical component diminishes more and more until at last only the horizontal component of the motion remains. In this case the separate parts of the earth move to and fro horizontally and produce the sensation of an undulating motion. Thus the preponderance of one or the other component of the motion can be considered as a criterion for the estimation of the relative distance of the observer from the epicenter.

(b) Number and duration of the shocks.

In many cases the earthquake consists of one single shock and lasts only a fraction of a second, and the most terrible destruction is the work of an instant. In most cases, however, a whole series of shocks of different force follow one another at shorter or longer intervals. Generally, weak shocks come first; then the principal shock occurs, and the end of the shock is composed of vibrations becoming gradually weaker and weaker. The seismic disturbance may, however, begin at once with the strongest shock and then die away with weaker tremblings. In this case the whole series of shocks is designated the earthquake, and the duration of the earthquake comprises the time, inclusive of the intervals, which elapses between its first appearance and the last vibration. The duration of an earthquake is generally overestimated, because the observers are surprised by the sudden appearance of the phenomenon, and usually remain excited for a time after its end before they come to their senses and are able to realize what has happened.

When the number of shocks which follow one another in a comparatively short time is very large, they are called a swarm of earthquakes. The space of time over which the shocks extend may comprise several days, even weeks and months. If one and the same district is repeatedly visited by such earthquakes, it is called a regular earthquake district.

(c) The after shocks.

A very violent earthquake is frequently followed by a large number of after shocks. The stronger the principal shock and the smaller the shaken area, the more numerous the after shocks. The time over which the after shocks extend may comprise several years. With the increase of time, however, the frequency of the after shocks diminishes. The district in which the after shocks make themselves felt does not always correspond entirely with that of the principal quake; the epicenters of the after shocks often occur at different places within the principal shaken areas.

Observers are in the habit of paying no attention to the after shocks, because they attach no importance to them in comparison with the principal shock. In view of this, it must be emphasized that, from the standpoint of earthquake investigation, the same importance attaches to the after shocks as to the most violent shock. Accordingly, every after shock must, with regard to the time, duration, and intensity, be noted with the same care as the first shock. In one respect the observation of the after shocks is even more important than that of many other seismic phenomena. In all probability the appearance of the after shocks is dependent on the changes of the air pressure on the shaken area and on the attractive power of the moon and sun. The after shocks are thus best qualified to throw light on the question of the periodicity of earthquakes.

(d) Intensity of earthquakes.

The force of a shock is usually given according to a conventional scale. The best known and most used is the earthquake intensity scale which De Rossi and Forel devised. It distinguishes ten degrees:

I. Microseismic motion, recorded only by seismic instruments.

II. Shock registered by seismographs, observed by a small number of observers who are in a state of repose.

III. Shock observed by several persons in a state of repose; strong enough for duration or direction to be estimated.

IV. Shock observed by persons in activity; shaking of moveable objects (windows, doors), cracking of the floor.

V. Shock generally remarked by the whole population; shaking of objects, furniture, beds, isolated ringing of house bells.

VI. General awakening of those asleep; general ringing of house bells; oscillation of hanging lamps; stopping of watches; visible oscillation of trees; isolated cases of persons quitting their houses in terror.

VII. Overturning of moveable objects, loosening of plaster on the ceiling and walls, ringing of church bells, general terror, but no damage to buildings.

VIII. Falling of chimneys, formation of cracks in the walls of houses.

IX. Partial or entire demolition of certain buildings.

X. Great catastrophe, ruins, fissures in the earth's crust, land slips.

In general one may make the observation that earthquakes are stronger in the surface strata than in the depths of the earth. The effect of an earthquake depends in a high degree on the nature of the material of the earth's crust concerned. It can thus happen that one and the same shock will be felt very differently under otherwise similar conditions in places which are situated near to one another.

(e) Effects of earthquakes on the earth's surface.

Faults, cracks, fissures, which run off in the most manifold directions, intersect and thus cut up the land into blocks, belong to the very transitory, because superficial, changes of the earth's surface. As a rule they close up again of their own accord. If the fissure reach into the underground water, springs and small drains are affected.

There frequently occur round holes, which resemble an inverted cone and which throw forth slimy water when a violent earthquake takes place. In this case sand cones, which have the appearance of craters, are formed.

More extensive transformations of the earth's surface give rise to clefts which by a greater extension in length, breadth, and depth may become real faults and which may be combined with vertical and horizontal displacements.

Movements of masses, such as landslips, mountainslips, and subsidences take place with earthquakes only when the soil is composed of loose or water-sodden material.

Particular consideration should be given to the movements that are manifested during earthquakes by water, whether of lakes or of the ocean. In the lakes the water masses begin to oscillate or else waves arise on the surface. Flowing water may be made stagnant. The most remarkable, however, are the events which may be observed in the sea during coast earthquakes, namely, the so-called earthquake tidal waves. How the sea water behaves during a coastquake, whether it first withdraws from the bank or whether a rise of the water first takes place, is not yet established.

The damage to buildings is of particular importance for the estimation of the direction of transmission and of the intensity of the earthquake waves. Here, however, it must be remembered that the stability of the buildings in relation to the earthquakes depends principally on the material used in the building and on the construction. If in one case old decayed huts fall in, and in another case massive dwelling houses only show cracks in the walls, it is not immediately to be deduced that the violence of the quake in the first instance reached a higher degree than in the second.

According to A. Faidiga, the principal forms of destruction observed in buildings are as follows:

1. Complete or nearly complete ruin of the buildings.
2. Falling in of the gable walls, with preservation of the side walls and of the superstructure of the roof.
3. Preservation of the gable walls with a partial falling in of the side walls with the superstructure of the roof.
4. Destruction of certain corners, generally the upper ones, and of whole ledges of the building.
5. Falling in of the whole wallwork, together with a sinking of the superstructure of the roof.

The destruction of buildings is due, in the first place, to the fact that all their parts do not yield equally in the direction of the wave. If the extension of length coincides with the direction of the shock, cracks will arise lengthwise. If the wall stands perpendicular to the direction of the shock, oblique cracks will be formed, and these lead more easily to collapse. If the wall is presented obliquely to the earthquake waves, the direction and size of the cracks will follow the law of the composition and resolution of forces; here, it is true, irregularities in material and construction have a determining influence.

3. DETERMINATION OF THE POSITION OF THE EPICENTER.

Apart from the knowledge of the nature of seismic phenomena in themselves, the aim of earthquake investigation is above all directed to determining the position of the epicenter in every single case. For that it is necessary to have numerous individual observations, in as many different places as possible, of the beginning of the shock, its strength, direction, and effect, for every individual place of observation. For this, those communications which firmly establish the nonappearance of the whole quake or of isolated phenomena are of value. Such negative statements serve partly for the understanding of the inequalities of the shock, and partly to determine the gradual diminution of individual phenomena in its expansion, and also to determine as exactly as possible the limits of its expansion.

The three elements, intensity, direction, and time of the shock, which are necessary for the establishment of the epicenter, belong, it is acknowledged, to those which it is most difficult to determine in every earthquake. Thus the greatest care should be given to the observation of these three elements, and only reliable statements should be made. Experience tells us that, especially in the determination of the time, deviations of several minutes from the true time occur. The observation of the moment of the shock is not always exact even in telegraph offices and railway stations, because the necessary care in setting the clock to the official time is not everywhere used. The inexactness is still greater when it is a question of ordinary house clocks or pocket watches, and even the later comparison of the pocket watch with a clock showing standard time often gives faulty results in consequence of the uncontrolled timekeeping of the watch.

4. PHENOMENA ACCOMPANYING EARTHQUAKES.

Among the phenomena which among others follow in the track of earthquakes, the most important is the sound phenomenon. Most frequently these so-called earthquake sounds immediately precede the principal shock. But cases have also occurred in which they take place simultaneously with it and still continue after the end of the quake. The nature of earthquake sound is variously given as roaring, whistling, howling, rolling, thunder, cracking, bellowing, etc. On the whole, two principal groups may be distinguished, namely, sounds long drawn out like the rolling of thunder, or shortly broken off, like the explosion of a mine.

Earthquake sounds occur in both earthquakes and seaquakes. The force of the noise stands in no relation to the force of the shock; feeble shocks may be accompanied by a very loud noise and vice versa. In many places noises are heard without any accompanying shock being felt. These so-called ground claps have special names in different countries.

The following scale is proposed by J. Knett for estimating the force of the detonations:

1. Detonation of the very smallest force; only dimly audible amid the greatest quiet and by laying the ear upon the ground.
2. Detonation of small force; amid the greatest quiet and absence of wind distinctly audible in the air; more distinctly by listening on the ground.
3. Detonation of medium force; a noise distinctly audible in the open air even without complete quiet; distinctly audible in a quiet, closed room.
4. Detonation of great force; strong terrifying noise.
5. Detonation of the greatest force; violent, thunder-like; similar to the report of not far distant cannon; general terror among the population.

Light and fire phenomena are also often reported as accompanying earthquakes, but it is not impossible that this may be a delusion.

5. INSTRUCTIONS FOR FILLING UP THE QUESTION CARDS.

(a) One is recommended to fill up the card immediately after the event, when one is still under a fresh impression of it.

(b) As a rule, a separate card is to be used for each separate earthquake. Even when several after shocks follow the principal shock on the same day, a special card should be used for each separate distinct shock.

(c) Information which has been obtained later from other persons for the completion of one's own observations is to be written on special cards.

(d) For the sake of certainty, the day of the week should be added to the date of the earthquake.

(e) In giving the time, it must be added whether it is local mean time or standard time.

Whenever possible, one should give not only the time of the beginning of the quake, but also that of the principal shock and of the end of the quake.

It is not sufficient for the observer to state at what time the earthquake took place according to his watch; he should as soon as possible compare his watch with a well regulated clock (post office, telegraph office, or railway clock). If a railway clock is used, one must be guided by the clock used for the inner service, as in many stations the outside clock intended for the use of the public is wrong by five minutes.

The watch correction is, however, not to be applied to the time statement, but is to be entered separately. If one's own watch is five minutes fast in comparison with the standard clock, one places a + (sign of plus) before the number of minutes and seconds, or in the reverse case a — (minus sign). Thus, for example: $5^h\ 43^m\ 30^s\ (+\ 5^m)$.

Even if the observer possess a good timekeeping watch, his time statement is subject to more or less inaccuracy, because according to the circumstances, especially at night, a certain time elapses before one is able to read the time. On this account at least the limits should be given within which the phenomenon has been observed.

(f) It is of value to know how much of the time observed is taken up with a sound preceding, simultaneous with, or succeeding the shock.

(g) Since the direction of shock and direction of propagation do not always coincide, particular attention must be paid to the direction in which unsupported objects are overturned, or in which direction furniture is displaced, or in which direction hanging lamps or fluids oscillate. If clocks stop or pictures knock against the wall, the bearings of the walls should be given.

(h) With regard to the nature of the shock, it should be observed whether only one or several consecutive shocks were felt, and whether a jerky or wave-like movement or only a trembling of the ground was felt.

Other remarks concerning the composition of the soil, etc., must be left to the discretion of the observers.

6. QUESTION CARD.

Earthquake................(day of the week)................19
Place.
At what time? h m s (local mean time) (standard time)
A. M. or P. M.?
Where was the observer?
In the open air?
In a house?
In which story?
Number, duration of the shocks?
Direction of the shocks?
What effect had the earthquake?
Earthquake sounds?
Behavior of springs, wells, etc.
Other remarks.
Address of the observer.

7. SAMPLE OF EARTHQUAKE NOTICE.

Earthquake. Monday, January 19, 1889.
Place. Ascoli Piceno.
At what time: 8h a. m. M. T. Rome.
Where was the observer? In the open air.
In which story? ———
Number and duration of the shocks: One shock; two seconds.
Direction of the shocks: E.—W. jerky, VIII.
What effect had the earthquake? Cracks in the walls.
Earthquake sounds. ———
Behavior of wells, springs. ———
Other remarks: Church bells began to ring. General flight from the houses.

Data desired relative to seaquakes.

1. Position of the ship at the time of the earthquake.
   What course was the ship sailing and how many knots was she making?
2. Place of the observer.
   Was the seaquake felt by the observer below the deck or on deck?
3. Time of seaquake.
   At what moment was the seaquake perceived?
4. Kind of motion.
   (a) Merely trembling or shaking or shocks?
   (b) Was the motion vertical or undulatory?
   (c) Were the shocks preceded by a trembling motion or were they followed by such a motion?
   (d) What is the motion to be compared to, and what impression did it make upon the observer?
5. Direction of the propagation of the motion.
   Was the direction of the motion from bow to stern or vice versa, or can a certain direction by the compass be stated?
6. The intensity of the earthquake is to be given in degrees of the following scale:
   I. Quite slight trembling, more like a noise; mostly heard only below deck (III of the Rossi-Forel scale).
   II. Slight trembling, by which a sleeping crew might be awakened (IV of the Rossi-Forel scale).
   III. Trembling of the whole ship, such as might be caused by large casks being rolled across the deck (IV of the Rossi-Forel scale).
   IV. Moderate shaking like that felt when the anchor cable is quickly slipped (IV of the Rossi-Forel scale).
   V. Rather a strong shaking, as if the ship were scraping on rough ground (IV of the Rossi-Forel scale).
   VI. Strong shaking by which light things may be moved; the wheel jerks in the hands of the steersman (V and VI of the Rossi-Forel scale).
   VII. Very strong shaking by shocks so as to make the timber work crack and to render it impossible to keep on one's feet (VII of the Rossi-Forel scale).
   VIII. Very strong shaking by shocks; masts and rigging as well as heavy things on deck are shaken (VIII of the Rossi-Forel scale).
   IX. Exceedingly strong shaking by shocks; the ship is thrown on its side, slackens, or is stopped (IX of the Rossi-Forel scale).
   X. Destructive effect; people are thrown down upon deck, the joints of the deck burst, the ship becomes leaky (X of the Rossi-Forel scale).
   Did the intensity vary with the single shocks or during the whole phenomenon?
7. Duration of the seaquake.
   (a) What was the duration of the shaking itself, apart from the noise, by which it was accompanied?
   (b) Were there single phases to be distinguished in the phenomenon?
8. Sounds.
   (a) Was a noise heard, and what was it to be compared to?
   (b) Did the noise precede the shaking, was it at the same time, or did it follow it?
9. Sea surface phenomena.
   (a) What was the state of the sea surface before the seaquake took place?
   (b) Did it remain in the same condition, or did any changes take place during the seaquake?
   (c) Was a single peculiarly high wave observed or a succession of them (height and length)?
   (d) Was the level of the sea, although smooth, raised, or did it bubble like boiling water?
10. The compass.
    Did a sudden variation of the needle take place during the seaquake?
11. Meteorological phenomena.
    (a) Was the temperature of the sea water higher after the seaquake than it was before?
    (b) What was the atmospheric pressure?
12. Extension of the seaquake.
    (a) Were any other ships near at the time of the seaquake, and if so, at wnat distance?
    (b) Was the seaquake perceived by them or not?
13. Earthquake and seaquake.
    In case the ship is lying in a harbor, inquiries are to be made on land concerning:
    (a) The beginning.
    (b) The intensity.
    (c) The duration of the earthquake.
    What difference was there between the earthquake and the seaquake as to these three points?
14. Condition of the sea in the harbor during an earthquake and a seaquake.
    (a) Had the shaking any influence upon the water in the harbor?
    (b) Did any breakers come in at the moment of the shaking or immediately after it, and if so, how many, how high, at what intervals?
    (c) Did the ship drag her anchor and were any currents perceptible.
    (d) Did a so-called earthquake tidal wave take place, and if so, how long after the beginning of the earthquake; how many waves, what height, at what intervals?

INDIAN SUMMER.

A correspondent writes to inquire "the time and duration of Indian summer" for the latitude of Washington, D. C.

Indian summer is an extremely indefinite season as to its date and its character. There has never been any determination of its average date and duration so far as we know. It is often described as a warm, dry, hazy period after the first severe frost in autumn, but it often fails to come at all.

The date of the first severe frost at Washington has ranged, since 1871, from October 2 to November 15, and at Baltimore, during the same period, the range has been between October 6 and December 6. This might serve to fix the earliest possible date for the beginning of Indian summer.

The paper by Mr. Albert Matthews on "The Term Indian Summer," which appeared in the MONTHLY WEATHER REVIEW for 1902 on pages 19 and 69, is one of the most complete and exhaustive discussions of the subject and its perusal is recommended to those who take an interest in this subject.

A LECTURE ON SNOW CRYSTALS.

Our esteemed correspondent, Mr. W. A. Bentley, of Jericho, Vt., whose beautiful photomicrographs of snow crystals are known the world over, devotes his whole thought to the prosecution of this work. Being unable to leave Jericho, owing to